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RESEARCH ARTICLE

Capturing attention: media and institutional narratives on carbon capture, utilisation, and storage in three EU countries

[version 1; peer review: 2 approved with reservations]

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v1 **First published:** 12 Mar 2025, **5**:67
https://doi.org/10.12688/openreseurope.19463.1
Latest published: 12 Mar 2025, **5**:67
https://doi.org/10.12688/openreseurope.19463.1

Abstract

Background

Carbon capture, utilisation, and storage (CCUS) technologies are emerging into the public arena as increasingly-discussed measures of climate change mitigation, and research into the complexities of public perception of these technologies is intensifying. Narratives, or storytelling, have emerged as a potential key shaper of public opinion of novel technologies, including CCUS.

Methods

In this paper, we aim to contribute to this research by identifying and analysing media and institutional narratives around CCUS in three EU countries. We use the Narrative Policy Framework to analyse publications over a two-year time period with respect to key components of storytelling, such as plots and characters.

Results

We find that overall, CCUS is still a relatively niche topic mostly discussed in an informative and neutral way, but that significant differences emerge between countries and across time in how emotionally charged "stories" around CCUS are being created.

Conclusions

Our results offer insights into the mechanics of how CCUS transforms from an abstract, unknown set of technologies to being part of stories designed to appeal to the public, with important consequences for public attitudes and perceptions.

Open Peer Review

Approval Status ? ?

	1	2
version 1 12 Mar 2025	? view	? view

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Keywords
carbon capture, carbon capture and storage, carbon capture and utilisation, public opinion, public perception, narrative policy framework



This article is included in the Horizon 2020 gateway.

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Author roles: Miu L: Conceptualization, Project Administration, Supervision, Writing – Review & Editing; **Panica D**: Data Curation, Formal Analysis, Investigation, Writing – Original Draft Preparation; **Niculicea AM**: Data Curation, Formal Analysis, Investigation, Writing – Original Draft Preparation

Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101022484 (CarbOn Neutral cluSters through Electricity-based iNnovations in Capture, Utilisation and Storage [101022484]). The sole responsibility for the content of this publication lies with the authors. It does not necessarily represent the opinion of the European Union. Neither CINEA nor the European Commission are responsible for any use that may be made of the information contained therein. The funder had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.
The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Miu L, Panica D and Niculicea AM. **Capturing attention: media and institutional narratives on carbon capture, utilisation, and storage in three EU countries [version 1; peer review: 2 approved with reservations]** Open Research Europe 2025, **5**:67 https://doi.org/10.12688/openreseurope.19463.1

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Introduction

To limit the global temperature rise to 1.5 degree Celsius above pre-industrial levels, widely considered to be the only way to avoid irreversible climate damage, the volume of carbon dioxide (CO_2) emitted into the atmosphere must be drastically reduced, and some already-emitted CO_2 must be extracted from the atmosphere (IPCC, 2019). In this sense, carbon capture, utilisation, and storage (CCUS) technologies have emerged as potential solutions for avoiding emissions and for reducing the amount of CO_2 already present in the atmosphere.

Broadly, CCUS involves a chain of processes, starting with capturing the CO_2 (either from point-source emissions, such as industrial flue gases, or directly from the atmosphere through direct air capture, or DAC), compressing and transporting it, and subsequently utilising it (carbon capture and utilisation, CCU), for example to produce fuels, or injecting it underground for permanent storage (carbon capture and storage, CCS). Collectively, CCU and CCS are referred to CCUS, an umbrella term which we will use throughout this paper. There are many technologies and pathways for CCUS, and their climate impact depends on the certainty and timescale of keeping captured CO_2 away from the atmosphere (Bellona, 2023).

To date, the global deployment of CCUS projects has been limited due to a range of factors, most prominently their significant investment requirements and relative lack of policy and regulatory certainty (Zapantis *et al.*, 2019). The International Energy Agency (IEA) estimates that the amount of captured CO_2 will need to increase 40-fold between now and 2030 to meet the goals of the Paris Agreement (IEA, 2021). Today, CCUS is receiving increasing attention in policy, industry, and research environments, and has been embedded as a key measure in the climate policy frameworks of major economies such as the European Union (EU), the United States, and China (Nielsen *et al.*, 2022).

One important aspect for consideration in the deployment of CCUS projects is that of public perception (Tcvetkov *et al.*, 2019). Negative or uninformed public perceptions of CCUS may lead to social resistance, particularly against projects which include transport and storage infrastructure situated in the vicinity of communities. The perceived risks of underground CO_2 storage are a dominant driver of resistance to CCS projects, but other social concerns around CCUS relate to the potential to misuse carbon capture to extend the use of fossil fuels ("fossil fuel lock-in"), (Nielsen *et al.*, 2022), the health impacts ("toxic nature") of CO_2 (Arning *et al.*, 2019), the novelty and cost of CCS (Thomas *et al.*, 2018), and scepticism towards the efficacy of CCUS as a climate change mitigation tool (Nielsen *et al.*, 2022).

With levels of lay public awareness of CCUS being generally low (Thomas *et al.*, 2018), the ultimate perception of these technologies will be dictated by the context and messaging surrounding a particular project, including trust in those communicating it. The interplay between context and messaging is captured in the formulation of narratives, or "stories" where events unfold in a plot marked by characters, symbols and dramatic moments (Jones & McBeth, 2010). Narratives are universally important elements of human cognition (Schlaufer *et al.*, 2022) which underpin the organisation, processing and dissemination of information by individuals (Jones & McBeth, 2010). As a means of communication, they allow receivers to identify more easily with the messages being conveyed (Guo *et al.*, 2019) and are thus potentially more persuasive than facts or abstract arguments (Bushell *et al.*, 2017).

This paper presents and compares the main media and institutional narratives around CCUS in three EU Member States (Denmark, Greece, and Romania) in the 2020–2022 period. The purpose of this research is to identify the main characteristics of CCUS narratives in these three countries, if and how they differ between countries, and whether any change is observable over the course of the two years of the study. The intention of this research is to contribute to a better understanding of how CCUS narratives emerge and evolve in European countries, and consequently how they might respond to and influence the deployment of CCUS projects.

Background

CCUS involves complex technologies deployed in large-scale projects with long development timelines. As a result, these technologies may often be perceived as abstract and difficult to comprehend by the public, as potential consequences are not fully known. Consequently, perception on CCUS is directly influenced by other underlying factors, such as trust in institutions (Broecks *et al.*, 2021; Pietzner *et al.*, 2011) or the credibility of information sources. These play an important part in shaping the perception of benefits and barriers for new technologies, as in place of knowledge, individuals can only judge a technology though the institution that brings up the topic to them (De Vries *et al.*, 2016; Terwel *et al.*, 2011; Wallquist *et al.*, 2010; Yang *et al.*, 2016).

Public perception of CCUS is also influenced by the perceived risks and benefits associated with these technologies (Merk *et al.*, 2022). Perceived risks directly tie to the issue of proximity to a project location (Krause *et al.*, 2014), with risk perceptions being higher for CO_2 storage projects than CO_2 capture projects (Linzenich *et al.*, 2019). Risk perception may shift due to benefits perception; (Merk *et al.*, 2022) illustrates how perceptions of CCS as threatening, uncanny disruptions to natural systems may be ameliorated through the portrayal of CCUS applications as playing an important role for sustainable economic development. The quality of communicated messages on CCUS also play an important role in shaping perceptions, as misconceptions and misleading information, in association with insufficient trust in institutions, can lead to rejection of large-scale technologies and the associated products (De Vries *et al.*, 2016; Terwel *et al.*, 2011; Wallquist *et al.*, 2010; Yang *et al.*, 2016). The impact of message quality is especially important given the role of the media in disseminating information on CCUS particularly as the media can be one of the main sources of information for topics related to policy or technologies for most individuals (Tcvetkov *et al.*, 2019).

Against this background of complex factors influencing the public perception of CCUS, the role of narratives has begun to emerge as a topic of research interest, given that the framing

of CCUS projects is an important component of successful public engagement (Witte, 2021). Existing research shows a potentially performative function of narratives in defining future CCUS trajectories, by expressing shared meanings that audiences use to make sense of the world around them (Nieto *et al.*, 1975). This role can be observed, for example, in cases of increased acceptance when CCUS is linked to employment benefits in industrial regions and contextualised within narratives of industry as a marker of social progress (Oltra *et al.*, 2020). A better understanding of the way narratives around CCUS are formulated and disseminated is thus an important area of research for informing public engagement around CCUS projects. However, there are still research gaps in understanding the role of narratives in formulating perceptions on CCUS. The focus of existing research tends to be on CCS, rather than CCU or DAC, (Nielsen *et al.*, 2022) and geographical coverage mostly confined to Western and Northern Europe (Nielsen *et al.*, 2022) whereas CCUS activity is expected to also emerge in the industrialised regions of Central and Eastern Europe (Miu *et al.*, 2021).

Narratives presented in media could play an essential role in determining the future trajectories of CCUS and, more generally, of the low-carbon energy transition (Asayama & Ishii, 2017). Because CCUS is still in the demonstration phase, and said demonstrators (particularly subsurface storage) may be invisible to wider societal audiences, social learning of CCS relies heavily on cultural representations and intermediaries, such as news stories. Indeed, certain research suggests that for unfamiliar technologies such as CCUS, media discourses may be a good proxy for public attitudes (Buure *et al.*, 2024). The choice of framing of CCUS shapes public perception, but research finding both positive and negative correlations between acceptance of industrial CCUS and its framing as a climate mitigation technology (Witte, 2021). Framing CCUS in a narrative of sustainable structural change may also shift public perception, particularly in regions with significant industrial heritage and an ongoing dependence on manufacturing employment (Boomsma *et al.*, 2020; Witte, 2021). In other contexts, CCS narratives may be linked to the continued use of fossil fuels, in some cases portrayed favourably and in others to underpin accusations of greenwashing (Buure *et al.*, 2024). Overall, the importance of media narratives in shaping public perception is significant, and in some cases, these narratives may determine the ultimate fate of CCUS projects. Therefore, exploring CCUS narratives in the media becomes a pivotal reference point for understanding the broader public discourse on CCS (Brumbaugh & Rupp, 2020).

In Europe, there are several widely circulated narratives surrounding CCUS. The first is that CCUS technologies is an essential part of achieving deep emissions reductions and mitigating climate change, particularly for sectors with so-called "hard-to-abate" emissions.[1] A second major narrative is on economic security, with CCUS put forward as the enabler of continued operation of heavy industries, reducing the risk of relocation due to high carbon prices in Europe. Which narratives are dominant is often difficult to elucidate and depends on the socio-cultural and political context and timing: for example, the United Kingdom's recently-elected Labour government has recently displayed narratives of "revival" and worker protection ("relighting the fire of areas hit hardest by deindustrialisation") around CCS projects (Partington, 2024); in Denmark, "technology pioneers" narratives are observed alongside economic revival ones, portraying CCUS as an enabler of decarbonisation in an overall discourse of technological optimism. There are also prominent narratives arguing against the need for CCUS: it is a "distractor" from actual sustainable change (Mota-Nieto & García-Meneses, 2024) and risks leading to carbon lock-in by allowing fossil fuel operators to continue their status quo.

A step change in the EU's approach to CCUS as a key decarbonisation measure, accompanied by a recent uptick in CCUS projects, is reflected in a growing interest in these technologies by large media outlets and EU institutions. According to the authors' own research, following a long period of relative silence, mentions of CCUS in key EU media and institutions increased in number year-on-year, linked to the launch of projects (e.g., Orca in Iceland) and political activity (e.g., the EU Green Deal). Many media publications and statements from EU institutions from the 2020–2022 period show an overall favourable position towards CCUS. During this period, mentions of CCUS also became more targeted, focusing more on industries with "hard-to-abate" emissions (IEA, 2020). In contrast, accusations of CCUS as a tool for "greenwashing" are also present in European media (Covarrubias, 2023). This shows that interest in CCUS has increased and deepened in the EU, in conjunction with the emergence of CCUS as a real part of the Union's decarbonisation portfolio and an attitude of relative hope to launch climate innovations at scale as part of a "green" post-COVID-19 recovery in Member States (Koasidis *et al.*, 2022), and by an increased focus on decarbonisation triggered by the Russian invasion of Ukraine.

With the rapid unfolding of CCUS projects across Europe comes a responsibility for social engagement with these still little-known technologies. Off the back of experience with social resistance to CO_2 storage projects in the EU, a growing area of research on social acceptance of CCUS has now developed, to which this paper seeks to contribute. The following section presents the methodology used in the analysis of CCUS narratives in the study countries.

Methods

This study uses the Narrative Policy Framework methodology (Jones & McBeth, 2010) to analyse media and institutional narratives on CCUS in the May 2020-May 2022 period (referred to as the "study period", in three EU countries (Denmark, Romania, and Greece, referred to as "study countries"). The selection of time period and countries is driven by the particularities of the ConsenCUS project, which this study is part of. The meaning of CCUS is restricted to the

[1] Hard-to-abate emissions generally refer to industrial emissions or emissions from other sectors which have few viable alternatives for emissions reductions.

capture of CO_2 from point-source emissions, given the focus of the ConsenCUS project. The selected countries are also relevant for CCUS applications, with Denmark being a frontrunner in technology deployment and Romania and Greece having economically significant heavy industries which may require carbon capture. Greece has recently increased its interest and activity in developing CCUS projects on its territory (for example, a CO_2 storage project in Greece was recently awarded the status of Project of Common Interest) (EnergyPress, 2023).

The main research question of this study is "how do narratives on CCUS vary between Denmark, Romania, and Greece?", with the main hypothesis is that these narratives will differ both in the media and institutional spheres. A second hypothesis is that narratives in countries situated in close geographical and cultural proximity (Greece and Romania) will be more similar to each other than to geographically and culturally more distant countries (Denmark). The study also looks at the evolution of these narratives over the 2020–2022 period, investigating a third hypothesis is that events such as political agreements or project launches will cause a change in CCUS narratives.

The research was conducted under the broad approach of the Narrative Policy Framework (NPF), a theory of policy analysis whose core assumption is that narratives (storytelling) play a central role in the construction of social reality. The NPF has been recommended for so-called "social site characterisation" in exploring CCS projects (Brumbaugh & Rupp, 2020). It is straightforward to apply and based on the assumption that narratives contain core elements whose presence can be assessed in order to better understand how CCUS narratives are being constructed. These core elements are those of policy narrative form (the setting of the narrative, i.e., space and time; the characters, i.e., heroes, villains, and victims; the plot; and the moral of the story) and of policy narrative content (the belief system and the strategies employed to manipulate and control policy processes) (Shanahan *et al.*, 2018).

This research uses a non-experimental research design and consisting of meso-scale level analysis, as recommended for conducting national-level analyses, as well as for analysing narratives used by stakeholder groups and coalitions (Shanahan *et al.*, 2018). The research design was operationalised by through content analysis of selected media articles and statements from public institutions, companies, and civil society in the three study countries. Of the reviewed articles, those which assumed a position on CCUS (pro-CCUS, anti-CCUS, ambivalent, or matter-of-fact), and which featured a "character" (such as a hero, villain, or victim), were further analysed with respect to the NPF codebook proposed by Shanahan, Jones, and McBeth (2018). Articles which only met one of the two above criteria were also analysed, but are not the main topic of this paper.

The main elements of the NPF analysed here are those of policy narrative form, as defined in the NPF codebook of Shanahan, Jones, and McBeth (2018): *characters* (heroes and villains, e.g., business, government; and victims, e.g., the environment), *morals* or *policy solutions* (e.g., a subsidy scheme for CCUS), *plots* (e.g., a villain government blames citizens for lack of action on CCUS, in a "blame-the-victim" plot (Table 1)), *causal mechanisms* (e.g., an unthinking business invests in CCS and by consequence loses trust from its customers through an accidental cause), and *costs and benefits distribution* (e.g., a CCS project places costs on an economic operator, but the wider benefits of climate change mitigation are distributed across society).

The morals (policy solutions) elements identified in the study data sources were often generic, simply referring to CCUS as a solution or distraction from the real solution, and few narratives focused on specific solutions for deploying or not deploying CCUS (e.g., subsidy schemes), with the exception of some Danish media and institutional statements. As such, the morals element is not presented in the result section.

Several adjustments were made from this original NPF codebook of Shanahan, Jones, and McBeth (2018), to increase its relevance for analysis of the CCUS topic.

- Stance on CCUS (pro-CCUS, anti-CCUS, matter-of-fact, or ambivalent/unclear)
- Categorisation of hero, villain, and victim stakeholders. The following categories were assigned for characters identified in the analysed narratives:

Table 1. Plot types used for assessment of CCUS narratives in this study. The full description of the plot types is provided with the extended data, available online at (Miu *et al.*, 2025).

Type 1 (based on Shanahan *et al.* (2018))	Stymied progress
	Story of decline
	Change-is-only-an-illusion
	Helplessness and control
	Conspiracy
	Blame-the-victim
	Truth claim
	Victory
Type 2 (based on Asayama & Ishii (2017); Janipour *et al.* (2021))	Climate/environmental effects narrative
	Economic effects narrative
	Employment narrative
	Technology narrative
	Lock-in narrative
Type 3 (based on Meadowcroft & Langhelle (2009))	CCUS is core in fossil world
	CCUS is nationally/regionally significant in mixed world
	CCUS is niche in decarbonized world

- Heroes and villains: business/industry; conservationists/environment; government/public sector; cultural/historical concerns; universities/researchers[2]; other.
- Victims: wildlife/nature/environment; economic concerns; cultural/historical concerns; safety/security concerns; social concerns; other human concerns; both bio and anthropocentric concerns.

- Narrative setting. As per Shanahan, Jones, and McBeth (2018), narratives focus on a particular space and time to define a setting on which to focus the attention of the audience. The setting can be narrow (e.g., a particular municipality) or wide (e.g., the world), whereas the time is logged as the year of publication of the narrative.
- Plot types. The original NPF codebook presents seven categories of plots as a means to organise the action in a narrative. This study uses two additional categorisation methods, based on Asayama and Ishii (2017) and Janipour *et al.* (2021), and on Meadowcroft and Langhelle (2009) (Table 1). Each plot is thus categorised according to the three methods.
- Use of scientific evidence. Given the complexity of the CCUS topic, the use of robust evidence in communications is essential. This parameter allows for the analysis of the presence of scientific evidence (e.g., citations of scientific research or expert opinion) in CCUS narratives. The study also reviews whether the presentation of evidence is complete (e.g., whether the narrative adequately addresses risks and uncertainties associated with CCUS).
- Policy stance. The overall stance of the narrative was categorised into "winning", "losing", or "projected to win". Due to the relative absence of discernible policy stances (note: as opposed to CCUS stances), these are not presented in the results section.
- Policy "surrogate" (termed "Links to wider narratives" in the results section of this paper. Whether or not the CCUS narrative is wrapped in a wider narrative, such as climate change or economic security.
- Angel- and devil-shift. Although traditional understanding of the angel-devil shift narrative strategy refers to the portrayal of heroes as winners and villains as winners (Shanahan *et al.*, 2018), respectively, in this study we refer to angel-shift as the process of casting the author of a narrative or their ally as a hero, and to devil-shift as the process of casting the author's opposition as a villain. This interpretation serves to identify instances of politicisation of the CCUS topic, an important dimension to the emerging CCUS debate.
- The presence of "extreme" narratives. This study adds an assessment parameter to the NPF codebook to record the presence of "extreme" narratives around CCUS, indicative of black-and-white thinking (primarily, *CCUS is indispensable and should be deployed at all costs*, or *CCUS is just a form of carbon lock-in, no matter its use case*).

The results section of this paper presents the above narrative elements as identified in the relevant data sources (articles or documents) from the study countries. Given the relatively low number of articles in the study countries, a qualitative analysis of results is performed.

The following section reviews the sources used for obtaining the media and institutional articles subsequently analysed under the NPF.

Data sources

Three main sources were used for extracting online articles and statements for NPF analysis. For all these sources, search term combinations in Danish, Greek, and Romanian were used to identify articles for review, published between May 1st 2020 and April 30th 2022. The main search term combinations were "carbon capture", "carbon capture and storage", "carbon capture and utilisation", "carbon capture, utilisation, and storage", "CO_2 capture", "CO_2 storage", "CO_2 capture and storage", "CO_2 use", and "CCS". In some cases, slight variations to the search terms were introduced according the common usage of the terms in the local language. The study did not cover print or audiovisual sources (TV, streaming or radio).

The three main data sources are as follows:

1. Media content: 5 most-circulated national publications at the time of writing; 5 most-circulated national publications for energy or climate news;[3] Google News search results for relevant search terms.
2. Institutional statements: public statements, speeches or press releases from decision-makers (national governments, Parliaments, and public agencies, the 10 highest-emitting economic operators in each country; NGOs and civil society).
3. Relevant national strategies and plans, such as climate strategies, industrial policies, and sectoral decarbonisation plans.

From all the above sources, textual (written) publications were reviewed. Any publication that mentioned CCUS at least once was reviewed, summarised, and analysed with respect to the two criteria mentioned in the previous section. Those publications which met both criteria were considered to qualify

[2] It should be noted that in the first year of the analysed time period (May 2020-May 2021), "universities/researchers" did not exist as category, and no narratives were found portraying universities/researchers as characters. The category was added for analysis of the second year of the time period (May 2021-May 2022) when universities and researchers began appearing as characters in the publications meeting the two criteria outlined above.

[3] See extended data for the detailed data sources for each country: Miu, Panica, and Niculicea, "Underlying and Extended Data for Assessment of Media and Institutional Statements on CCUS in Denmark, Romania, and Greece."

as narratives and logged in an NPF codebook, adjusted as described in the previous section (one codebook per country and per year of the study time period), for further analysis. Some codebooks included a separate sheet which includes articles that treat CCUS in depth, but meet only one of the two criteria for consideration as narratives. They are not reviewed in-depth in this paper.

Results

Applying the data collection methodology outlined above resulted in the extraction of a range of media articles, public statements, and national strategies discussing CCUS, in the three studied countries, for the 2020–2022 period (Table 2). The total number of publications across 2020–2022 was highest in Denmark, closely followed by Romania. Both Greece and Romania saw a significant uptick in general-circulation media articles discussing CCUS between the 2020–2021 and 2021–2022 periods.

Several notable commonalities and differences can be noted between the CCUS narratives identified in the three study countries. Public statements were mostly from private companies and authorities, and less so from NGOs. Authorities were more active in Denmark than in Greece and Romania in putting forward statements on CCUS, particularly in the 2021–2022 period; one remarkable feature is the statements on CCUS issued by Danish political parties, which are virtually absent in Greece and Romania.[4]

[4] As an example, Danish political parties issued 24 public statements on CCUS in 2021–2022, compared to 31 statements from private companies.

Narratives around CCUS were also far more prevalent in Danish national strategies (5 national strategies in 2020–2021 alone, including the 2020 National Climate Agreement for Energy and Industry and the 2020 North Sea Agreement). This is a major difference from Romania, where only two public institution statements were identified between 2020 and 2022. In Greece, no public statements on CCUS from authorities could be identified; however, the Hellenic Hydrocarbons Agency (a state-owned company) published an extensive study on CCS potential in Greece, as well as several press releases briefly mentioning CCS, as part of a wider portfolio of activities.

In terms of private companies, it is worth noting a concentration of public statements around a small number of companies in some of the analysed periods and countries. For example, in Romania, one single chemicals manufacturer discussed or mentioned CCUS five times in 2020–2021 alone (out of 16 public statements in that period), while in Denmark 10 out of 18 public statements from companies were from a single cement manufacturer, and a further 4 from an industry trade body, in the same period.

Of the identified articles, a subset was found to meet both NPF criteria and were further analysed (Table 3). These subsets also increased significantly year-on-year for Greece and Romania, while staying similar for Denmark. Notably, by the 2021–2022 period, both Greece and Romania had significantly more articles meeting both NPF criteria than Denmark.

The following subchapters describe the main elements of the adapted NPF framework and how they are reflected in the narratives meeting NPF criteria. The full codebooks for each country

Table 2. Number of identified publications discussing CCUS in Denmark, Greece, and Romania in the 2020–2022 period.

Country	Year	General-circulation media[5]	Specialised media	Public statements	National strategies
Denmark	2020–2021	52	17	43[6]	8
	2021–2022	46	20	68	8
Greece	2020–2021	42	N/A[7]	16	2
	2021–2022	111	N/A	14	0
Romania	2020–2021	33	38	13	1
	2021–2022	100	40	10	0

[5] Includes Google News search results.

[6] Includes statements on company, organisation or authority websites which are more than just a brief mention, and press mentions in which statements on CCUS are made.

[7] In Greece, no specialised media outlets (focusing on climate or energy issues) without paywall restrictions could be identified.

Table 3. Number of publications classified as narratives in the study countries across the study period.

Country	Year	Articles meeting both NPF criteria
Denmark	2020–2021	9 (4 media articles, 5 public statements)
	2021–2022	8 (3 media articles, 5 public statements)
Greece	2020–2021	2 (1 media article, 1 public statement)
	2021–2022	15 (10 media articles, 5 public statements)
Romania	2020–2021	11 (9 media articles, 2 public statements)
	2021–2022	26 (19 media articles, 7 public statements)

and each year of the study are available in the Zenodo data repository (Miu *et al.*, 2025).

Stances on CCUS

As one of the NPF criteria, stances on CCUS were observed in all articles meeting both NPF criteria (Table 3). Across all countries, the majority of stances were either pro-CCUS or matter-of-fact/ambivalent, with pro-CCUS stances dominating by the end of the analysed period.

In Denmark, the relatively small number of articles meeting both NPF criteria makes it difficult to draw robust conclusions on dominating stances. However, within the subset of articles meeting one NPF criteria (i.e., having a stance on CCUS, but no discernible characters), pro-CCUS stances increased in proportion between the two years of the analysed period, heavily dominating by the 2021–2022 period.

In Greece, anti-CCUS narratives meeting both NPF criteria were relatively more prevalent in the 2020–2021 period (two out of two narratives were anti-CCUS); by the 2021–2022 period, media and public statements on CCUS had significantly increased in number, with pro-CCUS stances dominating (5 pro-CCUS narratives, 1 matter-of-fact, but pro-leaning narrative, 1 ambivalent and 3 anti-CCUS).

In Romania, a general pro-CCUS or matter-of-fact positioning of narratives is observable across the entire analysed period. In the second year of the period, anti-CCUS narratives also appear (2 anti-CCUS articles, compared to none in the first year).

Heroes, villains, and victims

Heroes (positive characters whose actions are portrayed as socially beneficial) are generally the most common character type in CCUS narratives across all analysed countries and time periods. Hero portrayal is generally associated with pro-CCUS narratives, and as such increases across the analysed time period in Greece and Romania, as part of the overall increase in number of narratives. A range of entities are portrayed as heroes, significantly influenced by who the narrative author is, particularly in the case of public statements which were often self-congratulatory and portrayed the authoring entity as a hero (for example, industry or national authorities in Denmark engaging in self-congratulatory discourse on their CCUS intentions or projects). In Greek and Romanian media, several less common entities were also portrayed as heroes: universities and researchers for their work in developing CCUS technologies (Greece), and even CCUS technologies themselves (Greece and Romania) for their contribution to the transition (even labelled a "saviour" of the climate in a Greek article). In Romania, heroes are frequently foreign companies or Member States, as most Romanian media narratives present CCUS projects in other countries, with little to no link to the Romanian context.

Villains are less commonly portrayed than heroes, but tend to appear as the number of narratives increases and positioning diversifies: for example, villains are only subtly specified in the first year of analysed Romanian narratives, but emerge more evidently in the second year in anti-CCUS narratives (government as a villain, accused of ignoring the implications of applying CCUS to a specific use case) as well as ambivalent ones (industry). Overall, anti-CCUS articles tend to more explicitly villainise entities in their discourse; for example, a Danish article covering public opposition to Vattenfall's abandoned CO_2 storage project in North Jutland portrays the company as a villain, and local conservationists as heroes. However, articles which are not necessarily anti-CCUS may also villainise industry: one such article accused an industrial operator of not investing in CCUS despite receiving a tax incentive to do so. Government is also villainised in anti-CCUS articles, for example a Greek media article accusing governments of allowing continued pollution while relying on the "dubious effectiveness" of CCUS.

Given the prevalence of climate change as the context for CCUS discourse, the environment is most frequently portrayed as a victim in the identified narratives, particularly in pro-CCUS articles where the absence of CCUS is associated with climate change impacts. In some cases, environmental concerns are portrayed as a victim in anti-CCUS articles, where over-reliance on CCUS is portrayed as a risk to the environment. However, economic concerns (e.g., safeguarding industry, supporting

companies with the cost of CCUS) and to a lesser extent social concerns (e.g., avoiding job losses in industries which need carbon capture) are also observed as victim characters, with their prevalence increasing over the analysed time period. Non-environmental victim characters also increase in prevalence in Greek and Romanian narratives over the analysed time period, although they are less present overall than in Denmark. In rare cases, economic concerns are portrayed as a victim of CCUS, rather than a victim to be helped by CCUS. This occurs in narratives where the value-for-money of CCUS is questioned for specific projects (Denmark) or generally (Romania).

Although the majority of narratives featured one character, several anti-CCUS narratives were complex enough to present heroes, villains, and victims alike. In one Greek opinion piece (Sotiris, 2021), the heroes were the younger generation, the villains were an "elite" of economic and political actors, and the victims were both environment and human life. In another Greek narrative (Doukas, 2022), the villains were also both economic and political actors, while the victims were the scientists whose climate concerns are ignored.

A notable exception to hero prevalence were the Danish narratives meeting NPF criteria in the 2021–2022 period. In this period, none of the three identified media articles portrayed heroes, but all portrayed villains, particularly companies seeking to implement CCUS, and criticised over-reliance on these technologies. Public statements from industrial entities portray industry and government as heroes for advancing CCUS; however, other public statements villainise industry, with accusations of greenwashing and furthering vested interests.

Plot types

Across all countries and time periods, the most commonly observed plot types were in the Type 2 (type of effect) or Type 3 (role of CCUS) categories. Type 1 (storyline) plot types were much less common, and mostly observed in Danish narratives, where greater familiarity with the CCUS topic may enable a transition from factual explanations to storytelling. Indeed, in the analysed time period, 14 of the 17 Danish narratives meeting both NPF criteria showed Type 1 plots. In the first year, these were most commonly "stymied progress" (e.g., carbon taxes are impeding investment in CCS), hinting that inaction is delaying the green transition. Other Type 1 plots were "victory" (portraying an industrial CCUS actor as enabling the green transition), and "story of decline" (an anti-CCUS media narrative lamenting the possibility that conservationists' prior efforts to reject Vattenfall's CO_2 storage project may be reversed now that CCS is on the government agenda again – although this particular narrative is quite vague).

In the second year, plot types diversified, with the addition of "conspiracy" and "change is only an illusion" plots, and the disappearance of the "stymied progress" plot. The "conspiracy" plot was associated with a specific industrial operator, hinting at the company's preferential treatment being due to the influence they have on the government. The "change is only an illusion" plot was presented in concerns around over-reliance on CCUS, implying that massive deployment of CCUS, to meet climate targets is illusory and wishful thinking).

Among Danish narratives in the same period which met only one of the NPF criteria, the "stymied progress" narrative was also the most prevalent one ("we are promised too much and things happen too slowly"), alongside "change is only an illusion" ("although the technologies theoretically work, and several of them are likely to work, it doesn't help much if politicians don't ensure that they are put to use") and "conspiracy" ("politicians have been preoccupied with various evasive manoeuvres in trying to avoid the truth"), "helplessness and control" ("we matter more than we think"). An interesting exhibition of option 1 plots is in a commentary covering "climate scepticism 2.0", a phenomenon by which traditional climate scepticism (i.e., not believing in climate change) is mirrored by a rejection of current climate solutions in favour of future ones, giving power-to-X and CCS as an example.

Type 1 plots were less common in Greek and Romanian narratives. In Greece, one single "helplessness and control" plot type is identified in an anti-CCUS article, in the analysed time period. In Romanian narratives, particularly in the media where journalists sometimes resort to eye-catching titles and emotional content, type 1 plots are more frequent and include "stymied progress", "victory" and "story of decline". "Stymied progress" plots are observed both in anti-CCUS articles (e.g., CCUS deployment is slowing down climate action) and in pro-CCUS articles (e.g., politicians are "not listening" to companies' needs to implement CCS).

Within the Type 2 plot category, the majority of narratives exhibited a "climate/environmental effects" plot. "Economic effects" and "employment effects" are also present, particularly in Danish narratives. Technology-focused plots, where narratives focus on the technological aspects of CCUS, are also present in Denmark. In the second year of the analysed time period, an interesting new Type 2 plot, not identified in the first year, is a so-called "solidarity" plot. This plot centres around the development of CCS in Denmark having a positive effect on other countries, by permitting them to export their CO_2 to Denmark for permanent storage. Greek narratives exhibit a diversity of Type 2 plots across the analysed time period, including "employment effects", "carbon lock-in effects" (in two anti-CCUS articles) and multiple intertwined plots (combinations of environmental, economic, and employment plots). The lock-in plot was particularly present in the second year of the analysed time period, mostly in anti-CCUS articles. In Romania, a focus on "climate/environmental effects" plots is noticeable across the analysed time period, but second-year plots are observed to include more multiple intertwined plot types, covering economic, environmental, and sometimes social effects, particularly in public statements.

In the Type 3 plot category, there are notable differences between the study countries. In Denmark, the majority of narratives meeting both NPF criteria exhibited a "CCUS is niche in a decarbonised world" plot, is indicative of a general

tendency to speak about CCUS applications in a targeted way. The only Danish narratives which stop short of excluding CCUS for fossil fuel production ("CCUS is nationally/regionally significant in a mixed world") are found in the first year of the analysed time period. In Greece, while in the first year those narratives exhibiting a Type 3 plot presented a "CCUS is core in fossil world" plot, by the second year the only observable Type 3 plot was "CCUS is niche in a decarbonised world", focusing on heavy industry. Greek narratives meeting only one of the two NPF criteria mostly exhibited the "CCUS is nationally/regionally significant in a mixed world" or "CCUS is niche in a decarbonised world" plot. In Romania, in both years of the analysed time period, those narratives exhibiting a Type 3 plot presented a "CCUS is core in fossil world" plot.

Other NPF elements

Causal mechanisms

Across countries and time periods, most causal mechanisms identified in the analysed narratives are intentional; i.e., policy problems or solutions related to CCUS are the result of intended consequences by purposeful actions. Several notable exceptions are worth mentioning. In the first year of Danish narratives, the mechanical causal mechanism (intended consequences are associated with unguided actions and lead to a policy problem) is present in four narratives meeting both NPF criteria, and one meeting one of two NPF criteria (for example, the delay in deploying CCS is explained by an unthinking government failing to take political decisions, associated with a "stymied progress" plot). In Greece, inadvertent causal mechanisms (associating a problem with unintended consequences by purposeful action) are also present in four narratives meeting both NPF criteria and two narratives meeting one of two NPF criteria, for example implying that not managing CCS correctly and allowing for carbon lock-is an unguided consequence of a guided policy action.

Citing of scientific evidence

Narratives across the three countries were mixed in their use of scientific evidence, such as statistics or scientific reports, in their arguments on CCUS. The highest prevalence of narratives citing at least one scientific source regarding CCUS was in Denmark. Remarkably, this also included a media narrative from Ekstra Bladet, a widely-circulated tabloid-type publication. In Greece, both narratives meeting both NPF criteria in the first year cited scientific evidence; within those meeting only one NPF criterion, only three out of eight did so. In the second year, the increase in number of narratives was not necessarily accompanied by an increase in the use of scientific evidence: only 7 of the 15 narratives meeting both NPF criteria. Perhaps most pertinently, only one of the 5 public statements on CCUS in this year cited scientific evidence, mostly in the form of statements from scientific researchers. In Romania, nearly half of the media narratives and one out of two public statements were missing evidence from their portrayal of CCUS in the first year. In the second year, this had slightly improved for media narratives (12 out of 19 media narratives cited evidence), but remained low in public statements (1 out of 7).

Portrayal of costs and benefits associated with CCUS

Across all countries and time periods, benefits were more likely to be portrayed in narratives than costs. This is less the case in Denmark, where in the first year two out of three media narratives and four out of five public statements mentioned costs related to CCUS. In the second year, both media narratives and all but one of the public statements mentioned costs. Despite this, only a minority of narratives specify which entities will actually bear the mentioned costs. In Greece and Romania, in the first year of the study period more narratives portrayed benefits rather than costs; by the second year, more narratives in Romania had started portraying costs associated with CCUS, including public statements (six out of seven); however, in Greece costs were still only sparsely implied. In general, in all three countries costs were not specified in detail, and only rarely were the entities which would be bearing them identified. Benefits were mostly diffused to wider society given the primary portrayal of CCUS as a climate change mitigation tool. In many cases, anti-CCUS narratives failed to portray any benefits to CCUS, or portrayed benefits to the villains specified in the articles.

Linking to wider narratives

In Denmark, all analysed narratives placed the issue of CCUS in a larger normative one - mostly climate and environmental issues, but occasionally employment and economic competitiveness issues. This is also the case in Romanian media narratives, where climate, decarbonisation, and other environmental narratives dominate; in Romanian public statements, other wider narratives, including energy security, enhanced oil recovery and the use of gas as a transition fuel, are observed. In Greek narratives, first-year media and institutional narratives, as well as second-year institutional narratives, place CCUS in the context of wider issues. Second-year media narratives did this less; a number of articles focus on very specific CCUS applications (e.g., carbon capture as a solution for the shipping industry), with less contextualisation into wider climate or economic issues.

Angel- and devil-shift and "extreme" stances

Angel and devil-shift (the portrayal of the narrative author as a hero and of their opposition as a villain, respectively) are useful proxies for identifying vested interests within a narrative. "Extreme" stances of narratives can also indicate black-and-white thinking in portrayal of an issue, a useful aspect to analyse in the context of narratives on CCUS, a complex set of technologies with various benefits and drawbacks.

In Denmark, the presence of angel- and devil-shift increased from the first to the second year of the analysed time period, when two public statements displayed some amount of angel-shift, with the industrial entities authoring them hinting at themselves as heroic for advancing CCUS. In the same year, two media narratives and one public statement displayed devil-shift; this was clearer in the public statement, coming from an environmental NGO, where businesses are portrayed as the "opposition" and villainised for furthering vested interests leading to an inefficient application of CCS.

A similar shift was observed in extreme stances. While in the first year of the analysed time period only one article exhibited an extreme stance (a short article from an environmental NGO equating CO_2 storage with "hiding it away"), in the second year four extreme stances were noted, variously classifying

CCS as causing illusions of climate change mitigation, enabling "climate sinners" to pay less carbon tax, causing lock-in to expensive imports of biomass for BECCS, and being a business interest disguised as climate concerns.

Greek and Romanian narratives showed a different trend, in that they already had angel- and devil-shift and extreme stances in the first year of the analysed time period. In Greece, the only media narrative in the baseline year exhibited devil-shift and an extreme stance that CCS leads to carbon lock-in, in an anti-CCUS statement. The public statement, from an environmental think tank, laments the application of carbon capture to a Greek coal plant as a "fatal mistake" in an extreme stance, and uses devil-shift to villainise the responsible company.

By the second year, three of ten Greek media narratives, all anti-CCUS, exhibited devil-shift towards government and/or industry, and took extreme stances on CCS as perpetuating a fossil fuel status quo. One media narrative exhibited angel-shift and gushing language on portraying scientific researchers as heroes for developing carbon capture ("the Greek dream team"), but no extreme stance on CCUS itself. One single public statement from an environmental NGO exhibited devil-shift towards government and an extreme stance on CCUS as causing carbon lock-in.

Romanian narratives showed a different trend. Even in the first year of the analysed time period, one case of angel-shift was observed in a public statement from an industrial entity, and two cases, much more subtle, were observed in two distinct media narratives. Furthermore, four of the nine media narratives meeting both NPF criteria exhibited what could be considered as extreme stances – but as opposed to Denmark, these stances all portrayed CCUS applications as "inevitable" in some way.

By the second year, seven of the 19 Romanian media narratives meeting both NPF criteria exhibited angel-shift and three exhibited devil-shift (two of them anti-CCUS and one ambivalent). One anti-CCUS public statement from an environmental NGO villainised industry and government, exhibiting devil-shift, while a public statement authored by an industrial actor exhibited angel-shift. Five media narratives exhibited extreme stances – of these, two classified CCUS as causing carbon lock-in, while the remainder portrayed it as inevitable.

Discussion

The above results demonstrate two distinct sets of findings. Firstly, there are differences between countries in the formulation of narratives around CCUS, and these differences are more significant in between Denmark on the one hand, and Romania and Greece on the other, than between the latter two. Secondly, despite the relatively short analysed time period, there are noticeable evolutions in the narratives of the three countries, between the 2020–2021 and 2021–2022 period. These evolutions come against the backdrop of a major trigger event at EU level: the communication of the EU Green Deal in late 2021 and the subsequent legislative overhaul as part of the Fit-for-55 package, which relaunched CCUS on government agendas and began reversing a so-called "lost decade" in the deployment of CCUS projects in the EU.

The first key finding, namely the higher volume of published media articles and public statements in Denmark compared to Romania and Greece, can be attributed to key trigger events, both political (for example, new legislation, activities of the national government and agreements with the Danish Parliament) and technological (e.g., innovation activities of Danish universities). A key authorship difference – the authoring of statements on CCUS by political parties in Denmark, which was absent in the other countries – may indicate a sufficiently advanced position of CCUS on political agendas for narratives to have emerged, in attempts to convince voters of pro- or anti-CCUS stances. However, Danish publications meeting both NPF criteria were sparse, with most retaining a matter-of-fact stance and no significant change across the study time period.

The second key finding was the significant increase in the number of general-circulation media articles in Romania and Greece between the first and the second year of the study period. While this placed them significantly ahead of Denmark in the number of media articles mentioning CCUS, the ratio of media articles to public statements is also much higher. This may reflect a relative reticence of Romanian and Greek institutions and companies to broach the topic of CCUS, while media reporting on the subject increases. This may mean that in the absence of strong institutional stances on CCUS, public opinion is shaped by media articles, many of which fail to provide a balanced view on the complexities of CCUS. The role of the media in shaping public perception of CCUS thus becomes evident.

Another key finding relates to the way that publications approach CCUS. As with the previous two findings, the differences between Denmark and the other two countries are more evident than those between Romania and Greece. Particularly evident in the second year of the analysed time period, media publications are more likely to meet both NPF criteria in Romania and Greece than in Denmark, where the media shows a relatively fact-based approach and low prevalence of characters. Even in articles building storylines around Danish CCUS activity, characters are only sketched and not explicitly identified as bad or good, and the subject of CCUS is not emotionally charged enough to be significantly associated with typical hero-and-villain stories. In many cases, the matter-of-fact nature of media articles is due not to an unclear stance on CCUS itself (which is mostly positively portrayed) but rather to specific implementation concerns, including the planned start date for deploying CCS (too late), the location of envisaged storage sites (too expensive), the estimation of achievable emissions reductions through CCS (too optimistic) and the distraction from real emissions reduction measures (too risky). Overall, however, the relatively low share of articles meeting NPF criteria in Greece and Romania means that even though CCUS storylines are more evident than in Denmark, the subject is still mostly treated superficially.

The objectivity of Danish CCUS narratives may in part be due to journalistic style, but it is likely that the level of advancement of CCUS projects in Denmark also plays a role. The way that these narratives tend to propose specific solutions, such as financial support, public-private partnerships or CCUS

strategies, indicates that perhaps the CCUS debate has moved beyond promotion as a climate mitigation tool and into the realm of identifying solutions for its deployment, as opposed to Romania and Greece. Interestingly, there was a slightly higher tendency of institutional narratives to not do this, keeping statements general and promoting CCUS itself as a solution to climate change, job retention, or economic development, in the second year of the study period. This tendency is associated with a boom in government support for CCUS, indicating a potential link between public actors announcing financial support for CCUS projects and reiterating the potential benefits of these technologies.

This relatively pragmatic approach of the media is in contrast to a somewhat emotional one observed in the other countries (for example, CCUS technologies described as "amazing" or "world-saving" by the Romanian media, or "saviours of the climate" in Greek media). Similarly, this may be driven by underlying journalistic style: Henrik Örnebring (2009) describes the differences between "corporatist democratic" media systems in Northwestern Europe and "polarised pluralist" systems in the Mediterranean basin, including Greece. The same author points to post-communist Eastern European journalism as becoming "Italianised", transitioning towards highly opinionated and politically motivated journalism. In Greece, narratives went from a superficial discussion of CCUS in the first year of the analysed time period to an explosion of mostly pro-CCUS narratives, some with gushing language, with complex anti-CCUS narratives appearing as well. A similar trend is noted in Romania. On the other hand, despite an increase in Romanian and Greek public statements on CCUS over the study time period, which indicates an increase in the development of institutional CCUS storylines as the subject enters the public space, institutional stances are mostly weak and little detail is given on the role and implications of CCUS. This reinforces the idea that the media is the one building storylines and connecting the subject of CCUS to its readers, rather than the public institutions and companies which will have ownership of CCUS projects.

Another interesting finding is that in Romania, many media articles also construe CCUS as the subject of the narrative, rather than the narrative identifying a problem (e.g., emissions and climate change) and CCUS as a solution or part of the problem. This may show that CCUS may be seen as an intriguing technology in itself (as one article put it, "an amazing process") rather than part of a wider discussion on climate change mitigation. Furthermore, much of the media attention to CCUS in Romania is linked to events abroad, such as the launch of the Orca direct air capture project in Iceland and announcements on funding or investment for CCUS projects. This may decrease the relevance of the subject to Romanian readers. This is in contrast to Denmark, where narratives move past presenting the technologies themselves as a solution, and towards more specific solutions for enabling CCUS, such as establishing a national CCUS strategy. Trigger events are also closer to home, including national political agreements or funding decisions linked to the technologies.

The frequency of pro-CCUS statements and characters in Romanian and Greek media, compared to Danish media, is also an essential finding for public perception of CCUS. Janda and Topouzi (2015) suggest that people of all kinds more or less universally relish a positive and inspiring 'hero story', and that techno-optimistic narratives of CCS seem like an archetypal 'energy hero story', where CCS is a technological elixir that can fix climate change with no need for societal change. Pro-CCUS stances rooted in overly optimistic stories of CCS technology are thus not surprising; in fact, Mota-Nieto and García-Meneses (2024) highlights the existence of optimistic CCUS narratives rooted in "socio-technical imaginaries" rather than physical realities. In our study, optimistic stories are not necessarily related to continuation of the fossil fuel status quo, as evidenced by the high number of type 3 plots of "CCUS is niche in a decarbonised world", particularly in Denmark and Greece. However, while the penetration of this type 3 plot in Greek media accompanied the increase in media interest on the topic, Romanian media continued to advance the plot of continued fossil fuel consumption due to CCUS, creating fertile ground for anti-CCUS narratives centred around a carbon lock-in plot, as indeed observed in the second year of the time period. The stronger tendency to villainise specific entities in Romania and in Greece, compared to Denmark, may also be exacerbated by the prevalence of intentional causal mechanisms, which point to CCUS as being a purposeful decision with intended consequences, reinforcing accountability of those institutions in charge. Finally, the association of CCUS with negatively portrayed topics or entities may serve to foster negative public perception (Duetschke, 2023). For example, the association of CCS with a "climate sinner" industrial emitter in a Danish media narrative, may cause a spillover of negative public perception to CCUS technologies. In the case of Romania, media coverage of the submission of a questionable CCU project for funding may cause suspicion related to the technologies, particularly given interviews with national authorities which appear to deflect media questions on the project's effectiveness.

The results of this study also show that CCUS narrative plots evolve over the analysed time period. Over the analysed time period, new plot types emerge in Denmark ("change is only an illusion" and "conspiracy"), replacing plots centred around urging CCUS activity forward ("stymied progress"), in conjunction with an increase in angel-shift and devil-shift and "extreme" narratives. This indicates a deepening of the CCUS debate in Danish publications, as political progress accelerates and projects on the ground move towards deployment. Ekstra Bladet, a tabloid-type newspaper which did not release any articles on CCUS in the first year of the analysed time period, published three in the second year, including one calling out Denmark's largest industrial emitter as a "climate sinner" while reporting it as a beneficiary of CCUS subsidies. Public statements also shift over the study period, beginning to encompass more economic or employment-related plots (although these are still in the minority compared to climate- and environment-related plots). A few lock-in plots are present, worth noting given the concerns around indiscriminate application of carbon capture

manifested by the government's official advisory body on climate change,[8] in its public statements. In Greece and Romania, narratives start from a higher baseline of angel- and/or devil-shift and extreme stances in the first half of the study period, with their prevalence remaining relatively similar in the second half; one notable exception is Romania, where devil-shift becomes much more prevalent in this second half of the study period. Such critical narratives are essential contributors to achieving a balance between technical, economic, social, and political desirability of CCUS (Mota-Nieto & García-Meneses, 2024), but they must not generate misinformation and be based on a robust approach to the complex issue of CCUS.

In this sense, one potentially concerning finding is the lack of prevalence of scientific evidence in CCUS narratives, across all countries in this study. Even in Denmark, where the inclusion of scientific evidence and expert opinion is higher, many articles which include scientific evidence fail to present the whole picture, including risks and uncertainties, surrounding CCUS. This is slightly more noticeable in articles meeting both NPF criteria rather than those meeting just one, which had more neutral tones and presented more expert views, including on CCUS risks and uncertainties. This could indicate that as articles develop into storylines, they may forgo the discussing the complexities of CCUS as a suite of technologies with specific use cases. In Romania, the observed lack of scientific evidence is sometimes accompanied by a potentially misleading framing of CCUS as an "anti-pollution" solution. CCUS is a solution for reducing carbon dioxide emissions, rather than traditionally-defined "pollutant" emissions. This tendency to refer to CCUS in this way highlights the fact that Romanian audiences are more concerned with pollution mitigation rather than climate action, and creates a risk of overselling CCUS as a solution to problems that Romanian readers identify with more easily (Bucată, 2024).

Perhaps linked to the frequency of incomplete scientific evidence, the costs of CCUS (where implied) were less likely to be defined than the benefits, across countries. In many instances in which costs were specified, they were only partially detailed; for example, the agreements on deploying CCS only detail the public costs of the government subsidy pools, rather than the expected private investment. Whether or not costs are used as an argument in anti-CCUS articles varies: in Denmark, both pro-CCUS and anti-CCUS articles acknowledged the costs of the technologies; in Greece, both pro- and anti-CCUS narratives were less likely to acknowledge CCUS costs; in Romania, all anti-CCUS narratives mentioned the costs of CCUS. Benefits are mostly presented as diffused, positively affecting various forms of "society" or "population", with little identification of which groups in particular would benefit from CCUS.

The incomplete representation of the risks, uncertainties, and costs associated with CCUS creates a potential gap in the maturing of "hero stories" (i.e., the optimistic narratives of CCS dominating media and institutional statements in all three countries). As argued by (Asayama and Ishii (2017), a 'hero story' is most powerful and persuasive in the imaginary world (e.g., media discourse); however, in the real world, this heroic optimism will sooner or later be eclipsed and requires a 'learning story' including the risks and uncertainties pertaining to CCUS, to avoid that the promises of technology become failure. That is, there is a risk that any "inflated" hope portrayed in media narratives may widen the gap between expectations ("CCUS as a saviour of the planet") and reality, eventually leading to disappointment and a loss of confidence CCUS advocates (cf. (Asayama & Ishii, 2017)).To avoid or break this hope-disappointment cycle, hero stories should translate into or at least be complemented by learning stories, with more attentiveness to the costs, risks and uncertainties associated with CCS, instead of ignoring or obscuring them (Janda & Topouzi, 2015). Given prior social resistance to CCUS projects, as well as research sometimes showing neutral or negative effects of information or statistics provision on respondents' attitudes towards CCS (Buure *et al.*, 2024; Guo *et al.*, 2019) there is a risk that CCUS stakeholders choose to provide minimal information to the public, for fear of eliciting negative responses to potential projects. In this case, it is all the more important for narratives to provide adequate and balanced information on the benefits, costs, and risks associated with CCUS.

Limitations

This research faces several methodological and data limitations. Firstly, the positivist/structuralist approach of the NPF can simplify complex social realities by reducing them to predefined categories. This can lead to an oversimplification of the very complex and dynamic nature of narratives and create the risk of overlooking their contextual aspects.

Secondly, the NPF has an inherent subjective interpretation, as the application of decision rules and interpretation of the texts will differ between researchers. This subjectivity is mitigated, insofar as possible, through common definitions of the NPF categories analysed in the codebook, and regular exchanges between involved researchers as recommended by (Shanahan *et al.*, 2018).

Thirdly, algorithm biases, paywall restrictions and language barriers may have limited the coverage of data sources by this research. As Google News and the Google search engine have been used for gathering relevant media, underlying algorithms might have provided a bias in the types of media available for review and analysis. Paywall restrictions and language barriers also limited access to some media sources, possibly generating an unavoidable selection bias towards free media. It should be noted that for translating articles, automatic browser translation was generally used, supplemented by an AI-powered translator where needed (for example, for uploaded documents in pdf format).

Conclusions and recommendations

This paper has presented the results of an analysis of media and institutional narratives on CCUS in Denmark, Greece,

[8] It should be noted that this advisory body is an independent institution and not linked to governmental activities or positioning, including on CCUS.

and Romania over the 2020–2022 period. By using the NPF, the analysis elicited common themes and differences in how CCUS is portrayed in these countries, including associated stances, characters, and plots. It contributes to social sciences research on CCUS through a unique application of the NPF method to a multi-country analysis, and setting the scene for future in-depth research on CCUS narratives and their effect on public perception of and attitudes towards these technologies.

The key results of this research show significant differences in the portrayal of CCUS between Denmark, on the one hand, and Greece and Romania, on the other. While some of them may be driven by cultural factors, such as journalistic styles, there is a clear link between the volume and depth of CCUS narratives and the status of project and policy implementation in respective countries. This is also observed over time, with the slow advancement of CCUS projects in specific countries (such as Greece) leading to an increase in media narratives, the emergence of complex plots and anti-CCUS stances, and an increase in the portrayal of characters as part of new "CCUS stories". Even in countries where CCUS projects have not become a tangible reality yet (such as Romania), an increase in projects and discussions abroad has filtered down to a similar increase in reporting on this topic. Political interest, the involvement of NGOs, and media articles more tailored to local contexts are all hallmarks of an uptick in the public debate on CCUS in the three studied countries.

The application of the NPF method also offers interesting insights that can be leveraged in further research on CCUS narrative development. Eliciting general and CCUS-specific plot types points not only to what kind of role CCUS is expected to play (a technology prolonging the fossil fuel status quo or a niche solution for particular industries), what development it is hoped to drive (environmental, economic, social), and where it sits in the ever-evolving complex stories of the transition to climate neutrality (a mere theory detracting from "real" solutions, a vital solution being obstructed by political inaction, or an example of conspiracy between big business and government, to name a few). Identifying cases of angel- and devil-shift can also generate insights into whether and how CCUS is being politicised in the general debate on climate change mitigation. Clearly, the imbalanced information provision within the analysed narratives shows that CCUS research communities may play less of a role in formulating media and institutional narratives than may be optimal – particularly as academia and research organisations tend to be among the most trusted actors in Europe (European Comission, 2024).

While the transition from purely informative statements to more emotionally charged narratives is still nascent across the studied countries, the observed mechanics of this transition highlight several interesting points for further research. Firstly, the observed lack of institutional narratives in some study countries creates a public information void which is invariably filled by the media, which in said countries tends towards a simplistic representation of the complex issue that is CCUS. Potentially false "hero stories" can therefore emerge, creating unattainable expectations, and conversely anti-CCUS narratives can be propped up by misleading, overly-simplified information. It remains to be seen what effect this ownership of the CCUS topic by the media has on public attitudes, and whether these attitudes shift with increased institutional ownership. Secondly, the emergence of non-climate narratives, such as economic or employment plots, indicates that while CCUS remains primarily a climate change mitigation solution, as it enters the public discussion space narratives begin appealing to its potential as an economic development and job creation or retention tool. Further research could investigate the impact of this discourse shift on public attitudes. Finally, while CCUS remains a relatively niche topic, there is a strong indication from existing literature that the tone and views on CCUS, as well as public perception of it, will differ between national and local levels (Asayama & Ishii, 2017), especially if the local context includes a potential carbon storage site, and depending on the CCUS pathway being deployed. Given the importance of locality or place attachment for public perceptions (Asayama & Ishii, 2017) future research could explore how the evolution of national-level narratives affects local or site-specific ones, and how wider cultural meanings are embedded in local contexts where CCUS projects may become operational.

Ethics and consent

Ethical approval and consent were not required.

Data availability

Underlying data

Zenodo: Underlying and extended data for assessment of media and institutional statements on CCUS in Denmark, Romania, and Greece, DOI: 10.5281/zenodo.14801841(https://doi.org/10.5281/zenodo.14801841) (Miu *et al.*, 2025)

The project contains the following underlying data:

- Denmark_2020–2021.xlsx
- Denmark_2021–2022.xlsx
- Greece_2020–2021.xlsx
- Greece_2021–2022.xlsx
- Romania_2020–2021.xlsx
- Romania_2021–2022.xlsx

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Extended data

Zenodo: Underlying and extended data for assessment of media and institutional statements on CCUS in Denmark, Romania, and Greece, DOI: 10.5281/zenodo.14801841(https://doi.org/10.5281/zenodo.14801841) (Miu *et al.*, 2025)

This project contains the following extended data:

- Extended data_data sources.pdf
- Extended data_definitions of NPF criteria.pdf
- Extended data_sample codebook.pdf

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgments

The authors would like to thank the ConsenCUS project consortium for their openness to providing feedback and suggestions to strengthen this manuscript. The authors are grateful to Kostas Stavrianakis and Jacob Nielsen for their feedback on the research design and methodology.

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Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 27 May 2025

https://doi.org/10.21956/openreseurope.21059.r52354

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Comments by Section

Introduction
The introduction effectively touches upon the key themes of the research. However, it could be expanded to include more specific references to the European context, particularly through a few illustrative examples. This would help establish a clearer connection with the case studies discussed later in the paper. Additionally, while the cases of Greece, Romania, and Denmark are introduced, it is important to acknowledge that these countries represent distinct socio-political and cultural contexts. The authors should justify their selection of these particular countries and clarify the analytical value of comparing such diverse European contexts. Are their modes of action and narrative formation representative of broader trends? What insights are expected from juxtaposing these three cases? Including this rationale would strengthen the coherence and relevance of the study.

Background
The following citation could be appropriately integrated into this section to reinforce the relevance of the topic:
"Therefore, exploring CCUS narratives in the media becomes a pivotal reference point for understanding the broader public discourse on CCS (Refer 1& 2)."

Methods
- A brief contextual overview of each country with respect to CCUS would significantly enhance the reader's understanding. This should include cultural factors such as journalistic styles and, if available, the national stance or historical engagement with CCUS technologies.
- It is unclear whether any specific analytical tool was used in the coding and analysis process (e.g., Atlas.ti or another qualitative analysis software). This should be specified in the

methodology section. For example, the following passage could benefit from clarification: "From all the above sources, textual (written) publications were reviewed. Any publication that mentioned CCUS at least once was reviewed, summarised, and analysed with respect to the two criteria mentioned in the previous section. Those publications which met both criteria were considered to qualify as narratives and logged in an NPF codebook, adjusted as described in the previous section (one codebook per country and per year of the study time period), for further analysis. Some codebooks included a separate sheet which includes articles that treat CCUS in depth but meet only one of the two criteria for consideration as narratives. They are not reviewed in-depth in this paper."

Results

Overall, the results section would benefit from more precise quantitative data. For instance, instead of using vague terms such as “the majority,” the authors could include simple statistics (e.g., percentages or frequencies). This would enhance the rigor and formality of the analysis and provide a clearer picture of the trends being described.

Discussion

Several important elements could be addressed or expanded upon in the discussion:

- The specific time frame of the study should be more explicitly discussed, particularly the fact that it overlaps with the COVID-19 pandemic. This period saw a dramatic and unprecedented drop in global emissions, which may have influenced media narratives and offered a unique window of opportunity to promote CCUS as part of broader climate action strategies.
- While the introduction highlights the potential societal impact of CCUS narratives, the analysis focuses primarily on top-down narratives from media and institutional sources. To offer a more comprehensive picture, the authors could briefly address the absence of bottom-up, public-driven narratives. Acknowledging this gap—while remaining within the scope of the study—would reinforce the importance of incorporating multiple perspectives in future research.
- To further enrich the discussion, the authors should reflect on the implications of the narratives presented. What might such narratives trigger at a national level? How might they influence the decision-making landscape? Understanding the framing of CCUS in the public discourse is essential for anticipating policy uptake and implementation challenges.
- It is also important to emphasize that although Greece, Romania, and Denmark are all EU member states, they differ significantly in their political histories, institutional capacities, and societal priorities. Treating them as a homogeneous unit risks overlooking critical contextual nuances.
- Finally, the role of the private sector in shaping CCUS narratives deserves mention. Private actors often have vested interests that may skew public discourse and influence policy trajectories. The authors should also highlight that the period under review—marked by the COVID-19 crisis—likely influenced both the quantity and tone of media coverage. A brief reflection on the potential limitations of studying such an exceptional moment in time would add depth and transparency to the paper.

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2. https://www.osti.gov/biblio/1664756.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: I have dedicated the past five years to working on sustainability and carbon capture and storage (CCS) projects, with a particular focus on evaluating narratives as tools to foster collaboration among diverse stakeholders. My expertise lies in the design and development of both computational and human-centered platforms that bridge science and decision-making, particularly within the framework of a frontier research institution. With over 25 years of experience in the environmental and sustainability sectors, I have recently expanded my work into the energy sector, recognizing its pivotal role in shaping more sustainable and resilient development pathways.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 02 April 2025

https://doi.org/10.21956/openreseurope.21059.r52353

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The article is well-written and has a clear structure. It contributes to the literature on CCUS in Europe in assessing the narratives about CCUS in 3 countries. While it constitutes a interesting contribution and relies on a sound methods, there are two fundamental points I'd like the authors to address or respond before indexing.

1-As the authors acknowledge in the limitations section, the NPF is positivist and somehow simplistic approach to complex problem such as CCUS. This leads the paper in a normative stance about what should be the "right" position about CCUS. This is visible in the state of the art where the authors stand for a "deficit model": people don't know enough about CCUS and that's why they are opposition (the idea that they might oppose for a good reason is not even mentioned). Can the authors explain the causal mechanism behind their way of thinking the decision-making process? and the subsequent role attributed to the "public". Following that point, there is no mention of the procedural process about CCUS in each country. Their important work about the narratives is not made understandable in the singular process where they took place.

- First, one could think there are many differences in discussing a new policy framework for CCUS or a new single project, this is not the same to debate about the role for CCUS in a distant future or to be confronted with a new project for newt year in a localised place.
- Second, how the authorities are managing the decision process matters to understand the reactions and narratives: do we a public debate before decision. Is the government trying to impose its solution against opposition? Does this government have good or bad ratings at this moment? etc. We lack contextual information about the 3 cases to understand why people are talking about CCUS the way they do. I'd like to suggest two articles dealing with that: Hansson, et al., 2022 in ERSS [Ref-1] and Chailleux, et al., 2023 in Journal of Env Policy and Planning [Ref-2].

2-While the methodology is duly defined. I have doubts about three important elements.

- First, I find the number of validated documents quite low (less that 10 per year for Denmark). Is it still possible to draw conclusion based on such a few documents? Can it be possible to stretch the methodological guidelines to integrate more articles even though they would have only one criteria (instead of two)?
- Second, I would like to have more information about the journals. As the authors acknowledge it in the end, the media framing is determinant but we do not know how many articles came from left or right-wing press, national or local newspapers, economy or environment section? Some of the results can be explain in recontextualizing their publication: in the economy section of a liberal newspaper, CCUS will be framed as a good solution 9 over 10 times.
- Third, I also think the selection of data contain a bias because it put on the same level media and institutional publications but they do not meet the same goals (and do not contain the same stories). Can it be possible to have a separate analysis given these two types of data (if they are divergent)? Furhtermore, it can explain the low level of negative narratives: public institutions usually publish report on a political mandate (they were ask to) and may be prone to publish more info on CCUS than NGO who need the resources and the urgency to publish such documents. Finally, while it is already well explained, the methods remain quite difficult to follow for a non-NPF scholar. The paper would gain from more accessibilty about this section.

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Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Policy studies; energy and environment policies

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.